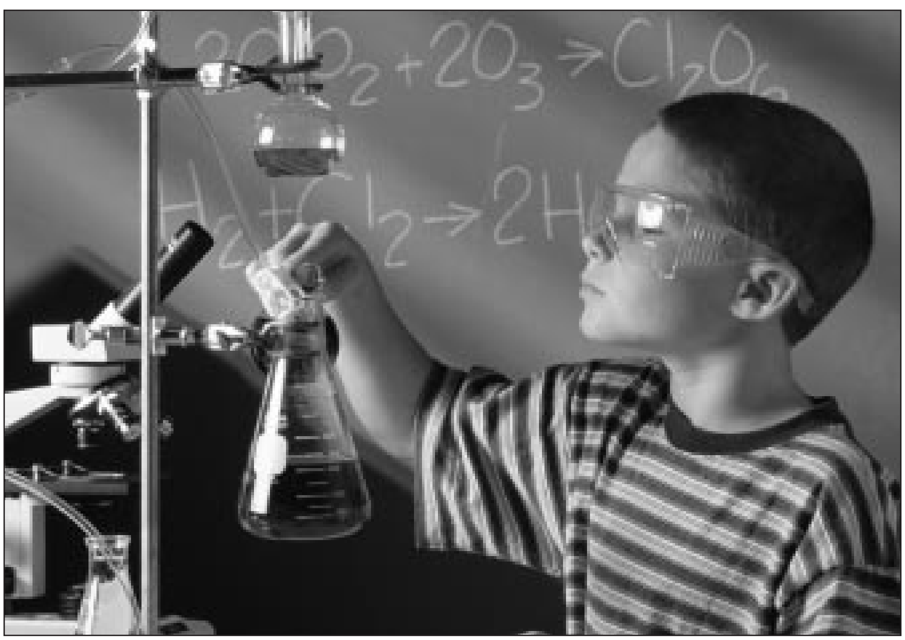
Chapter 4

ANALYZING AND SELECTING SCIENCE CURRICULUM MATERIALS



At periodic intervals (usually every five years or so if the budget allows), New Jersey schools and school districts review and select science curriculum materials. Adoption committees often invite commercial publishers to submit their materials for consideration. Publishers' salespeople respond by submitting sets of well-illustrated, full-color textbooks with teacher's guides, resource books, videotapes, videodiscs, and computer software. Other publishers, especially at the K-8 level, offer a different kind of science program: a series of inquiry-centered science modules. These programs may or may not have accompanying print materials for students, and they often come with equipment kits.

The decision about which science curriculum materials to use is one of the most important professional judgments that educators make. Adoption committees make recommendations that influence classroom instruction for years to come. The decisions teachers make about which modules, units, or chapters to use and in what order largely determine what and how students will be expected to learn. These decisions are far too important to be based on a cursory examination of superficial properties of curriculum materials or made in response to publishers' sales pitches. Even a more in-depth review of the topics covered in the materials may not be sufficient to determine whether the material will help students learn the content or whether it is aligned with standards.

How can the district adoption committee choose among all the different products? Are there any guidelines that the committee can use to make the job easier? And who should be on the committee? A high-stakes educational decision of this sort often involves expensive collateral purchases of science equipment and materials and supportive educational *technology*, in addition to the curriculum materials themselves. Such a critical decision must involve all the key stakeholders who will implement the program once it is adopted.

GETTING STARTED: ASSEMBLING A CURRICULUM COMMITTEE AND ASSESSING NEEDS

The process of identifying people to serve on a science curriculum committee differs in scale and numbers. The goal is to initiate a broad-based collaborative process. If a large district is reevaluating its entire K-12 science curriculum prior to a district-wide adoption of new programs, a very large committee will need to be assembled that includes the following:

- A team of K-12 teachers responsible for science instruction from all elementary, middle, and high schools in the district
- The science coordinator
- The *technology* coordinator
- The mathematics coordinator
- Building principals
- Administrators in charge of instructional services and staff development

- Parents (who can be especially helpful when the question of adopting programs comes up before the school board)

- High school students (if desired)

- Business partner representatives who may provide support and expertise

- Any outside professional development partners who will be responsible for providing teachers with staff development activities on the materials before and during their implementation in the classroom

This committee can then be broken down into subcommittees: K-4, 5-8, and 9-12. In addition, we recommend establishing a K-12 articulation subcommittee, composed of representatives from the three grade-cluster subcommittees, which would review the results of the other three committees and assess gaps and duplication across grade ranges and schools.

The process of identifying people to serve on a curriculum committee would be similar for a smaller-scale situation—for example, a single K-4 elementary school—but would involve fewer individuals. It may still be desirable to break the committee up into two subcommittees: K-2 and 3-4. In the simplest case where, for example, the task is to consider selecting a new course in high-school biology, only one committee would be needed. In all cases, however, including building principals is crucial because of scheduling and other implications of implementing inquiry-based science programs.

In any multigrade or multischool analysis, the initial task for the subcommittees is to map and describe the *existing* science curriculum materials used in the school or district at that level. Current assessment and instructional practice should also be reviewed and discussed. In order to do this, it is necessary to assemble all science textbooks, lab books, and teacher's guides; CD-ROMs, software, or other *technology*-based science programs; units of study developed by teachers in the district, if any; and any science kits or assessments currently in use by students in school or district classrooms and media centers.

Examining either existing district materials or ones proposed for adoption requires getting below the surface by focusing on the appropriateness of their content and the nature of their instructional design. Specific learning goals are the key to this process. Until recently, there was nothing against which to judge appropriateness of content and instructional design. Now, as a result of the standards-based reform movement in education, these judgments can be made with a high degree of confidence. In science, the appearance of the following three documents laid the groundwork:

- *Science for All Americans* (AAAS Project 2061, 1989), which describes what all high school graduates should know and be able to do

- *Benchmarks for Science Literacy* (AAAS Project 2061, 1993)

- *National Science Education Standards* (National Research Council, 1996)

The *New Jersey Core Curriculum Content Standards* in science (May 1996), which were developed in light of the national standards and finalized following a broadly collaborative process, define the specific learning goals against which curriculum materials need to be judged in our state. These *Science Standards*, along with the three documents listed above, should be reviewed by the subcommittees. The subcommittees will then be ready to start analyzing curriculum materials for alignment with them.

THE PROJECT 2061 CURRICULUM-ANALYSIS PROCEDURE

A five-step curriculum-analysis procedure developed by the AAAS Project 2061 is being incorporated into a U.S. Department of Education *Instructional Materials Tool Kit*. The procedure is based on the learning goals presented in Benchmarks. We have adapted the procedure to help those who are analyzing and selecting curriculum materials to promote the specific learning goals in New Jersey's *Science Standards* and cumulative progress indicators (CPIs) for grades 4, 8, and 12. Below are the five steps, as adapted for the *New Jersey Science Curriculum Framework*:

Identify the standards and cumulative progress indicators that will serve as the intellectual basis for the analysis. This task must be done before beginning to examine any curriculum materials. For instance, in the case of the committee whose task is to analyze their existing high school biology program against the standards and possibly select a new one, all the CPIs for grades 9-12 in *Science Standard 6* ("All students will gain an understanding of the structure, characteristics, and basic needs of organisms") and *Science Standard 7* ("All students will investigate the diversity of life") would clearly need to be identified. The committee would also want their biology program to be well aligned with the 9-12 CPIs for *Science Standards 1-5* (the science process standards), which include the important areas of systems, problem solving and inquiry skills, and mathematical modeling. The committee might or might not identify the environmental standard (*Science Standard 12*) as one that they want to evaluate the course materials against. Similarly, they might or might not want to identify particular CPIs within other content areas important to the understanding of biology—for example, indicator 12 of *Science Standard 8*, which deals with the different types of chemical reactions and the factors affecting reaction rates, or indicator 7 of *Science Standard 10*, which expects students to identify the age of fossils and to explain how they provide evidence that life has changed through time. The point is that this process of specifying learning goals has to precede the review of any curriculum materials against them.

Make a preliminary inspection of the curriculum materials to see if they are likely to address the targeted learning goals. The next step is to make a first pass at the materials to identify those whose content and approach appears to correspond reasonably well to the learning goals. All the various components of a given curriculum package—e.g., readings, experiments, discussion questions—need to be skimmed in order to get an overview of the program. If matches cannot be found for a significant number of the identified Science Standards and CPIs, the material is dropped from the list of programs being examined.

Analyze the curriculum materials for the alignment between content and the selected learning goals. This analysis is a more rigorous examination of the link between the subject material and the selected learning goals within the narrowed list of curriculum materials. The material is examined using questions such as the following:

- Does the content address the substance of a particular CPI or only the general topic? At the topic level, alignment is never difficult, because most topics—heredity, weather, magnetism, etc.—lack specificity, making them easy to match. The analysis has to be sufficiently "fine-grained" to be meaningful.

- Does the content reflect the level of sophistication of the specific CPI, or are the activities more appropriate for an earlier or later grade level? Curriculum materials need to be age-appropriate for the intended students. Chapter 15 of *Benchmarks* ("The Research Base") contains helpful references for this purpose.

- Does the content address all parts of a specific standard or only some? It is not necessary that any particular unit address all the ideas in a standard, but the K-12 curriculum as a whole should do so.

Analyze the curriculum materials for the alignment between instruction and the selected learning goals. The purpose here is to estimate how well a given set of materials addresses targeted *Science Standards* and CPIs from the perspective of what is known about student learning and effective teaching. The criteria for making these judgments are derived from research on learning and teaching and on the craft knowledge of experienced educators. Chapter 15 of *Benchmarks* ("The Research Base") and chapter 3 of *National Science Education Standards* ("Science Teaching Standards") are helpful references in this regard. Important criteria considered in this step of the analysis include the following:

- Providing a sense of purpose

- Taking account of student ideas

- Engaging students with phenomena

- Developing and using scientific ideas

- Promoting student reflection

- Assessing progress

- Enhancing the learning process

Summarize the relationship between the curriculum materials being evaluated and the selected learning goals. Having analyzed whether the content in the material matches the specific *Science Standards* and CPIs and how well the instructional strategies support students learning these *Science Standards*, the final step in the analysis is to provide a profile of the material based on the analysis.

Project 2061 is in the process of developing *Resources for Science Literacy: Curriculum Evaluation*, a CD-ROM tool that will offer full instruction in using this procedure. The CD-ROM and its print companion volume will also contain case-study reports illustrating the application of the analysis procedure to a variety of science curriculum materials and a utility for relating findings in the case-study reports to state and district learning goals.

THE NATIONAL SCIENCE RESOURCES CENTER SELECTION CRITERIA

The National Science Resources Center (NSRC), under the sponsorship of the Smithsonian Institution and the National Academy of Sciences, has taken a major leadership role in the reform of elementary science education. Following the publication of the *National Science Education Standards (NSES)*, the NSRC developed *Science for All Children: A Guide to Improving Elementary Science Education in your School District*. The chapter entitled "Criteria for Selecting Inquiry-Centered Science Curriculum Materials" presents three sets of well-tested criteria that district adoption committees can use as they review elementary science materials. The first set concerns pedagogical appropriateness, which encompasses strategies for building conceptual understanding, teaching science as inquiry, and applying effective instructional strategies. The second set concerns science content; the third deals with the presentation and format of the written materials. The three sets of criteria are listed below.

Criteria for Judging Pedagogical Appropriateness

A. Addressing the Goals of Elementary Science Teaching and Learning:

- Do the materials focus on concrete experiences with science phenomena?
- Do the materials enable children to investigate important science concepts in depth over an extended period of time?
- Do the curriculum materials contribute to the development of scientific reasoning and problem-solving skills?
- Do the materials stimulate students' interest and relate science learning to daily life?
- Do the materials build conceptual understanding over several lessons through a logical sequence of related activities?
- Does the instructional sequence include opportunities to assess children's prior knowledge and experience?

B. Focusing on Inquiry and Activity as the Basis of Learning Experiences:

- Does the material focus on student inquiry and engage students in the processes of science?
- Does the material provide opportunities for students to gather and defend their own evidence and express their results in a variety of ways?

C. Using an Effective Instructional Approach:

- Does the material include a balance of student-directed and teacher-facilitated activities as well as discussion?
- Does the material incorporate effective strategies for the teacher and/or students to use in assessing student learning?
- Does the teacher's guide suggest opportunities for integrating science with other areas of the curriculum?
- Do the students have opportunities to work collaboratively and alone?

Criteria for Judging Science Content

- Is the science content current and accurately represented?
- Does the content emphasize scientific inquiry?
- Is the content of the science program consistent with the *National Science Education Standards*? [See discussion below.]
- Does the background material for teachers address the science content that is taught, as well as common misconceptions?
- Is the treatment of content appropriate for the grade level?
- Is the content free of bias?
- Is the writing style for students and teachers interesting and engaging, and is scientific language used appropriately?
- Is scientific vocabulary used to facilitate understanding rather than as an end in itself?
- Is science represented as an enterprise connected to society?

Criteria for Judging Presentation and Format

- Are the print materials for students well-written, developmentally appropriate, and compelling in content?
- Are the directions for implementing activities clear in both the teacher's guide and student materials?
- Are the suggestions for instructional delivery in the teacher's guide adequate?
- Are the materials free of ethnic, cultural, racial, economic, age, and gender bias?
- Are appropriate strategies provided to meet the special needs of diverse populations?
- Are lists of materials for each activity provided, as well as a complete set of materials and information about reasonably priced replacement materials?
- Are safety precautions included where needed?
- Are instructions for using laboratory equipment and materials clear and adequate?

As in the case of the Project 2061 curriculum-analysis procedure, the NSRC criteria can easily be adapted for use with New Jersey's *Science Standards* and CPIs. In this case, there is only one question that would need modification: the one that specifically addresses the content in the *National Science Education Standards* (question 3 under "Criteria for Judging Science Content").

In fact, even for use with the NSES, a more detailed breakdown would be desirable because their content standards for grades K-4 take up 20 pages. New Jersey schools using this approach to evaluate early elementary science programs would want to determine if the content of the programs were consistent with all the K-4 CPIs for New Jersey *Science Standards 6-12*. If they were reviewing K-6 programs, they would want to look at the CPIs for grades 5-8 as well.

An explanation for each of the criteria, along with examples drawn from exemplary elementary science programs, may be found in the Science for All Children chapter. For example, the explanation accompanying question 5 of the third set of criteria listed above ("Criteria for Judging Presentation and Format") points out the need to accommodate students with different learning styles as well as those students with special needs:

> The curriculum materials should acknowledge the validity of different learning styles and include different kinds of learning activities, such as those that emphasize visual learning, auditory learning, and tactile learning. In addition, the materials must take into consideration students with physical disabilities and those with limited English proficiency.

We recommend careful review of these discussions. Schools and districts interested in using or adapting these criteria should review the entire chapter.

The NSRC suggests that converting the criteria into a checklist for reviewers is an effective way to evaluate curriculum materials and make sound curriculum decisions. Another approach would be to set up a numerical scale—for example, 1 through 5—for each of the criteria. This is the approach taken in the National Science Foundation's *Review of Instructional Materials for Middle School Science*.

Here is how each of the NSF review questions is set up:

Do the instructional materials provide sufficient activities for students to develop a good understanding of key science concepts?

1.........................2.........................3.........................4..........................5

Too many concepts and few learning activities	Activities provide some opportunity for students to learn some important concepts	Activities provide many rich opportunities to learn key science concepts

The complete "Framework for Review" is given in Appendix A of the NSF document, which also includes a descriptive listing of exemplary middle school science programs.

REFERENCES AND RESOURCES

In addition to the standards documents referenced in this chapter, the following recommended resources have been used and excerpted:

American Association for the Advancement of Science. 1997 (April). *The Project 2061 Curriculum-Analysis Procedure* (Draft of a Work in Progress). For further information, call AAAS Project 2061 at (202) 326-6752.

National Science Resources Center. 1997. “Criteria for Selecting Inquiry-Centered Science Curriculum Materials” (chapter 5). In *Science for All Children: A Guide to Improving Elementary Science Education in Your School District* (pp. 63-75). Washington, DC: National Academy Press.

The National Science Foundation Directorate for Education and Human Resources. 1997. *Review of Instructional Materials for Middle School Science* (NSF Publication 97-54). To order this publication, call (703) 306-1130 or send an e-mail to <pubs@nsf.gov>.